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Original Research Article

Spatial localization of impacted maxillary canine – A comparative study between OPG and CBCT

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ABSTRACT

Background: Maxillary canines are the second most frequently impacted teeth after the third molars. Bucco-palatal localization is the primary diagnostic task during radiographic examination of impacted maxillary canines for proper treatment planning. Such localization is done by a combination of clinical and radiographic findings. However, it is necessary to identify cases requiring 3D cone-beam computed tomography (CBCT) scans in addition to 2D orthopantomograms (OPG) for accurate diagnosis.
Materials and Methods: OPG and CBCT images of 75 impacted maxillary canines (IMC) were included in the study. Each OPG was evaluated for magnification index. The data obtained was tabulated and subjected to statistical analysis.
Results: The present study revealed higher prevalence of impacted maxillary canines in females (73%), with a slightly higher prevalence on the left side (53%). Most of the impacted canines were present in the mid-alveolus region. All the cases had 100% concordance between OPG and CBCT while locating palatal and mid-alveolar impacted canines whereas for buccally impacted canines, the concordance between OPG and CBCT was 93%.
Conclusion: Early radiographic examination and diagnosis are essential to recognize impacted maxillary canines. The sequela of delayed eruption or treatment of impacted canines may be severe resorption of the adjacent lateral and central incisors.

1. Introduction

Impaction is a pathological condition defined by the lack of eruption of a tooth in the oral cavity within the time and physiological limits of the normal eruption process.[1] Maxillary canines are the most commonly impacted teeth, second only to third molars.[2,3] In various studies, their prevalence has been found ranging between 0.8 and 2.8%.[2,3] There are many available definitions for an impacted tooth, but according to Lindauer, a canine is considered to be impacted if does not erupt after complete root formation or if the contralateral canine erupted at least 6 months previously and has complete root formation. According to Bass, impacted teeth are those which remain embedded in the jawbone or mucosa for more than 2 years following the physiological eruption time.[4]

Impacted Maxillary Canines (IMC) generally occupies a palatal position (85%) instead of a vestibular one (15%). These impactions are more commonly found in female

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patients than in male ones with a 2:1 ratio.[5] However, palatally impacted canines seldom erupt without surgical or orthodontic intervention due to the thick cortical bone and dense palatal mucosa. Moreover, palatally impacted canines are often in a horizontal or oblique direction.[2]

The canines are not only of high aesthetic value but also play an important role in guiding occlusion and maintaining the smile line. Impacted canines may result in several complications such as displacement and root resorption of adjacent teeth, cystic degeneration, canine ankylosis, shortening of the dental arch or combinations of these factors.[3] Accurate radiographs are critical for determining the position of impacted canines and their relation to adjacent teeth, assessing the health of the neighbouring roots and determining the prognosis and best mode of treatment. The most commonly used diagnostic aids for establishing the position of the impacted canines are periapical radiographs, occlusal films and orthopantomograms.[1,6] All of the modalities are 2-dimensional and require the use of at least one additional radiograph for an accurate spatial localization of an impacted maxillary canines. The conventional radiographic techniques which suffice for simple cases of impaction, but difficult cases require correct diagnosis as well as precise location and accurate assessment of the relation with the adjacent teeth and the surrounding anatomic structures, making advanced radiography useful in planning the treatment.[1,7]

The introductionof cone-beam computed tomography (CBCT) scans indentistry has brought a revolution indiagnosis and treatment planning by providing 3D volumetric data for a patient, that have been proven to be useful for the diagnosis of impacted teeth, treatment planning, and the identification of associated complications.[1,7] The use of CBCT could expose more radiation than lateral cephalometric radiography and OPGs, which are required for routine orthodontic diagnosis. OPGs have multiple indications in dentistry, are routinely used for orthodontic treatment plans because of their useful clinical information and low cost. Literature shows that the sagittal locations of IMCs, as "labial" or "palatal" can be predicted easily on OPGs, perhaps reducing the need for CBCT and leading to less exposure to radiation.[7,8]

Therefore, this study was conducted to compare CBCT technique with panoramic radiographs in localization of impacted maxillary canine, to compare the accuracy and efficacy of panoramic radiographs and cone beam CT in detecting impacted maxillary canines**.** The results of this study may help in formulating guidelines for determining the location of maxillary impacted canines on OPG.

2. Materials and Methods

The present study group comprised of 75 impacted maxillary canines, which might be unilateral or bilateral having a digital panoramic radiograph and cone-beam computed tomography scan, using purposive sampling technique. The radiographs were collected from the archives in the department of oral medicine and radiology. Diagnostic and clinical information for each patient was retrieved including general systemic disease, ongoing medication, developmental disturbances, history of orthodontic/orthognathic treatments, facial trauma/skull surgery and dentoalveolar surgery.

2.1. Inclusion criteria

Collected data should have the impacted canines, unilateral or bilateral with age of 18 years and above whose OPG and CBCT both were taken was included in the study.

2.2. Exclusion criteria

Any patient with missing central incisors, developmental anomalies, gross abnormalities of dental arches, craniofacial syndromes, systemic condition affecting tooth structures of canine, cysts and tumours involving the maxillary impacted canine, history of orthodontic/orthognathic treatments, facial trauma or surgery were excluded from the study.

2.3. Method of evaluation

Panoramic radiographs (OPG) were made using a Carestream CS 9000, (Carestream Dental, Atlanta, Ga) radiography unit. Each OPG was evaluated for Magnification Index, to assess the position of impacted maxillary canines using the CS 3d viewer software. The widest mesiodistal crown dimension of each impacted canine and ipsilateral central incisor was measured, and the Canine-Incisor Index values were calculated. (Figure 1 A) The widest mesio-distal (MD) dimension of the impacted canine was measured on a line perpendicular to its long axis. The widest mesio-distal dimension of the ipsilateral central incisor was measured on a line perpendicular to its long axis. In each case, when the contra-lateral canine is in correct position (unilateral canine impaction cases), its widest mesio-distal dimension were also measured. (Figure 1B).

Canine Incisor Index [CII] was calculated using the formula

$$CII = \frac{Widest\ MD\ dimension\ of\ canine}{Widest\ MD\ dimension\ of\ ipsilateral\ central\ incisor}$$

In cases with unilaterally impacted canine, Canine Canine Index [CCI] was calculated using the formula.

$$CCI = \frac{Widest\ MD\ dimension\ of\ the\ impacted\ canine}{Widest\ MD\ dimension\ of\ the\ erupted\ canine}$$

The measurements determined were recorded as the magnification index. When the CII or CCI values were less than 1.15, the impacted canines was considered to be buccally placed and when more than 1.15, they were considered as palatally placed, based on the cut of point

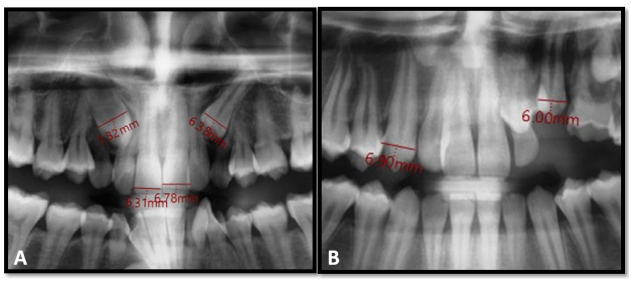

Figure 1: A): The widest mesiodistal crown dimension of each impacted canine and ipsilateral central incisor was measured, and the Canine-Incisor Index values were calculated in OPG; **B)**: When the contra-lateral canine is in correct position (unilateral canine impaction cases), its widest mesio-distal dimension was also measured on OPG

as suggested by Chaushu S, et al. This was based on the fact that for a given focal spot-film distance, objects placed palatal to the image layer appears excessively magnified in the horizontal plane, while buccally located objects appear proportionally diminished.

For each subject CBCT (cone-beam computed tomography) scans in DICOM format were obtained from a cone-beam computed tomography machine (CBCT) machine (Carestream CS 9000, Carestream Dental, Atlanta, Ga). The CBCT data volumes were reconstructed using Ez3D2009 CBCT software and the labiopalatal position of impacted canines were assessed in static cross-sectional reformatted images. (Figure 2) In assessing CBCT studies, examiner reviewed the entire volume and was allowed to reformat images. The labiopalatal position of canines was classified as labial, mid-alveolus and palatal, depending on the relative position of the canine crown to adjacent teeth.

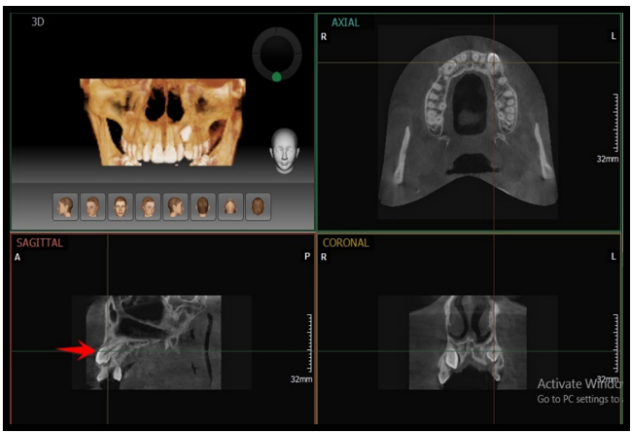

Figure 2: Showing buccally placed canine in cross-sectional reformatted images in CBCT

2.4. Statistical analysis

The readings were analyzed by the statistical expert in SPSS (statistical package for social sciences) 22.0 version software. Statistical procedure was carried out in two steps, data compilation and presentation and statistical analysis. The data obtained was compiled systematically, transferred from a pre-recorded proforma to a computer in Excel spread sheet and the master chart was prepared. The total data was distributed meaningfully and presented as individual tables. The predicted positions of impacted canines were compared using the Kruskal-Wallis test with p value < 0.05 was considered statistically significant.

3. Results

A total of 75 IMCs were evaluated, of which, 55 belonged to female patients and 20 belonged to males. Of the total 75 IMCs, 43 were located palatally, 26 were located buccally and 6 were located in the mid-alveolus on OPG. Of the total 75 IMCs, 41 were located palatally, 28 were located buccally and 6 were located in the mid-alveolus on CBCT.

4. Discussion

Disturbances in the eruption of maxillary permanent canines are common because the most superior area of development and the most difficult path of eruption compared.[9] According to Dewel, maxillary canines have the longest period of development, as well as the longest and most tortuous course to travel from the point of formation, lateral to the piriform fossa, until they reach their final destination in full occlusion.[10]

The present study aimed to detect the simplest radiographic parameters that can be studied to predict maxillary canine impactions on routine OPGs. In the literature, generally five different methods have been reported for localizing the maxillary IMC in sagittal direction on a single OPG. These are: (a) the superimposition of the IMC crown on the root or neck of the adjacent incisor; (b) sector determination; (c) magnification; (d) vertical level or the position of the IMC crown; and (e) angulation (the angle between the occlusal plane and IMC axis).[8] Nevertheless, as reported by several authors, the reliability of OPG in the anterior maxilla is limited: an overestimation of impacted canines angle and distance compared to the midline is generally present. Furthermore, in patients with small inter-incisors angles or with an important inter-maxillary discrepancy, apical or coronal parts of anterior teeth could appear out of focus or even invisible.[11] However, the more detailed information yielded by 3D techniques.[12]

Various studies have been conducted to compare OPG with 3D imaging techniques like CBCT. Ehsan Eslami et al. (2017)[13] concluded that CBCT is more effective than conventional radiographs in evaluating cases that are

Table 1: Mean mesiodistal dimensions of impacted canines and ipsilateral incisors or erupted contralateral canines according to side

Position		Right	Left	Kruskal Wallis Test (Gender) P- value
	Palatal	7.3	7.1	
Impacted Canine	Mid alveolus	6.5	7.4	0.99
	Buccal	6.8	6.3	
Ipsilateral Incisor Or	Palatal	5.9	5.4	
Erupted Contralateral	Mid alveolus	6.9	6.1	0.20
Canine	Buccal	6.5	6.8	

*p-value less than 0.05 is considered statistically significant

Table 2: Mean mesiodistal dimensions of impacted canines and ipsilateral incisors or erupted contralateral canines according to gender

Position		Male	Female	Kruskal Wallis Test (Gender) P- value
	Palatal	7.7	7.1	
Impacted canine	Mid alveolus	7.4	6.7	0.98
	Buccal	6.9	7.2	
Ipsilateral incisor or	Palatal	5.9	6.1	
erupted contralateral	Mid alveolus	7.5	6.8	0.54
canine	Buccal	6.4	6.9	

*p-value less than 0.05 is considered statistically significant

Table 3: Canine incisor index [cii] or canine canine index [CCI]

Position	Palatal	Mid alveolus	Buccal	Kruskal Wallis Test (Gender) P-value
Male	1.1	1.7	1.2	0.89
Female	1.1	1.6	1.1	
Right	1.1	1.2	1	0.32
Left	1.4	1.1	1.3	

*p-value less than 0.05 isconsidered statistically significant

Table 4: Concordance of position of maxillary canine on OPG, with CBCT

Position	OPG	CBCT	Concordance with CBCT
Palatal	49 (55%)	39 (52%)	100%
Mid alveolus	7 (9%)	7 (9%)	100%
Buccal	27 (36%)	29 (39%)	93%

difficult to diagnose.[13] Grisar K et al. (2019)[14] also found that 3D enabled imaging systems like CBCT gave better imaging regarding the localization of impacted canines than conventional radiographs.[14]

Based on the results of the present study; there was a slightly higher prevalence of impacted canines on the left side (53%), compared to the right (47%), (Table 1) which is similar to the findings reported by Al-Zoubi et al.[15] (2017) reported a higher prevalence of impacted canines on the left side(58%), compared to the right side (42%). Similarly, Alassiry (2019)[4] reported that impacted canines occurred more commonly on left side (52%) compared to right (48%).[4] Although there is no clinical significance of this prevalence on the left side, it has been considered as a general trait of this malformation.[15]

However, the results of the study conducted by El Beshlawy DM and Ahmed DF (2019)et al.[16] found an almost equal distribution of impacted maxillary canines on both sides (23 on the right (51%) and 22 on the left (48.9%) side).[16] This slight difference can be attributed to the difference in the geographical location and the population type of the study, and a huge difference in the sample size between the two studies.

Based on gender, there was a higher prevalence of impacted canines in females (73%), compared to males (27%) in the present study. (Table 2) This was in accordance with various studies reported in the literature, which have shown a higher prevalence of impacted canines in female, such as the study conducted by El Beshlawy DM and Ahmed DF (2019) et al.,[16] which reported a 83.3% prevalence in females, compare to only 16.7% in males.[16] This disproportion in gender distribution may be attributed to the smaller jaw sizes of females, which might impact the eruption of teeth in its proper place. Moreover, this may be due to the fact that females are more concerned about their esthetic appearance, which might lead them to report

to dentists, more frequently compared to males, leading to a higher prevalence observed by dentists.

The present study showed that a higher number of impacted canines were placed in the palatal region, followed by buccal and the mid-alveolus region, (Table 3) which differs from the results of the study conducted by Kumar RA et al. (2023),[9] who reported incidence of buccal canine impaction seems to be greater followed by palatal canine impaction and the mid alveolus canine impaction is the least.[9]This difference in the prevalence of bucco-palatal position of impaction may be attributed to the difference in the sample size, since the present study had a sample size of 75, whereas Kumar et al. (2023)[9] only had a sample size of 20 subjects. Moreover, their study was conducted in a different population, compared to the present study.

According to the present study, there was almost a 100% concordance between the findings of OPG and CBCT regarding the position of the impacted canine. Palatal and mid-alveolar positions had a 100% concordance whereas, buccally placed canine was slightly difficult to locate on OPG, compared to CBCT since it showed 93% agreement. (Table 4) Conversely, a systematic review by Eslami and Barkhordar et al., (2017)[17] concluded that there was only fair to moderate agreement between the CBCT (cone-beam computed tomography) and conventional radiography methods for the localization of impacted canines.[17]Moreover, contrary to the findings of the present study, Sarikir et al., (2017)[18] found no correlation between OPG (Orthopantomogram) and CBCT (Cone-Beam Computed Tomography) regarding the bucco-palatal position of the impacted maxillary canines.[18]

Because of the technique of obtaining radiographs, the image of labially impacted maxillary canine crown is projected onto apex of lateral incisor in OPG, which might prove to be a very complex area to diagnose and therefore, require CBCT imaging for accurate diagnosis. Possible sequelae of impacted canines include cyst formation, internal resorption of the impacted tooth, external resorption of impacted or neighbouring teeth, ankylosis, infection and migration of neighbouring teeth with loss of arch length.Practitioners should be aware of normal canine development, relevant investigations, and of dental anomalies such as peg-shaped lateral incisors that occur concurrently, so that early recognition and interceptive treatment can be carried out.[19] The precise location of these canines is important to formulate the best treatment plan for its eruption into occlusion.[4]

5. Limitations

The results in the present study were not statistically significant (< 0.05). This indicates that the mean values of canine width, incisor width and magnification index did not differ significantly between different positions of impacted canine. Thus, magnification index may be an important tool to predict the position of an impacted canine. This study has not included various other methods.

6. Conclusion

Canines play a vital role during development of occlusion and in esthetics of the face, and therefore play a major role in treatment planning. The sequela of delayed eruption or treatment of impacted canines may be severe resorption of the adjacent lateral and central incisors. In summary, this comparative study investigated the spatial localization of impacted maxillary canines using Panoramic Radiography (OPG) and Cone-beam Computed Tomography (CBCT). The findings revealed a higher prevalence of impacted canines in females, with most located in the palatal region. OPG and CBCT demonstrated high concordance in locating palatal and mid-alveolar impacted canines, with a slightly lower concordance for buccally impacted canines. The study highlighted the importance of early radiographic examination and diagnosis for effective treatment planning. While CBCT provides detailed 3D data, its higher radiation and cost should be considered.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Anand DY, Rani MS, Anand D, Gujar A, Shailaja AM. Overview of diagnostic tools in maxillary canine impaction. *Indian J Orthod Dentofac Res*. 2016;2(3):94–9.
2. Hsu YC, Kao CT, Chou CC, Tai WK, Yan PY. Diagnosis and Management of Impacted Maxillary Canines. *TJO*. 2019;31(1):4–11.
3. Jung YH, Liang H, Benson BW, Flint DJ, Cho BH. The assessment of impacted maxillary canine position with panoramic radiography and cone beam CT. *Dentomaxillofac Radiol*. 2012;41(5):356–60.
4. Alassiry A. Radiographic assessment of the prevalence, pattern and position of maxillary canine impaction in Najran (Saudi Arabia) population using orthopantomograms - A cross-sectional, retrospective study. *Saudi Dent J*. 2020;32(3):155–9.
5. Pico C, Vale FJF, Caramelo F, Corte-Real A, Pereira SMA. Comparative analysis of impacted upper canines: Panoramic radiograph Vs Cone Beam Computed Tomography. *J Clin Exp Dent*. 2017;9(10):1176–82.
6. Ramkumar A, Raghunath N, Munaif V, Chandran N, Kabeer S. Fidelity of orthopantamograms and CBCT in predicting position of impacted canines. *Int J Appl Dent Sci*. 2019;5(4):38–41.
7. Mushtaq N, Shamal S, Hassan N, Shah JU, Ali H. Comparison of Prognostic Indicators of Maxillary Impacted Canine using OPG(Orthopantomogram) with CBCT (Cone Beam Computed Tomography). *J Gandhara Med Dent Sci*. 2022;9(2):23–8.
8. Senisik NE, Karacin G, Yildirim D, Cesur M. The Reliability of Panoramic Radiographs in the Evaluation of Location for Impacted Maxillary Canine Teeth: Comparison of Prediction Methods. *J Clin Diagn Res*. 2019;13(7):18–24.
9. Kumar SRA, Amin V, Ramesh A, Hashim S. Evaluation of the position of impacted maxillary canines using panoramic and CBCT imaging - a retrospective study. *Eur Chem Bull*. 2023;12(7):6364–77.

10. Kumar S, Mehrotra P, Bhagchandani J, Singh A, Garg A, Kumar S, et al. Localization of impacted canines: A review. *J Clin Diagn Res*. 2015;9(1):11–4.
11. Dalessandri D, Migliorati M, Visconti L, Contardo L, Kau CH, Martin C. KPG Index versus OPG Measurements: A Comparison between 3D and 2D Methods in Predicting Treatment Duration and Difficulty Level for Patients with Impacted Maxillary Canines. *Biomed Res Int*. 2014;2014:537620. doi:10.1016/j.sdentj.2020.03.014.
12. Sudhakar S, Patil K, Mahima VG. Localization of impacted permanent maxillary canine using single panoramic radiograph. *Indian J Dent Res*. 2009;20(3):340–5.
13. Eslami E, Barkhordar H, Abramovitch K, Kim J, Masoud MI. Cone-beam computed tomography vs conventional radiography in visualization of maxillary impacted-canine localization: A systematic review of comparative studies. *Am J Orthod Dentofacial Orthop*. 2017;151(2):248–58.
14. Grisar K, Piccart F, Al-Rimawi AS, Basso I, Politis C, Jacobs R. Three-dimensional position of impacted maxillary canines: Prevalence, associated pathology and introduction to a new classification system. *Clin Exp Dent Res*. 2019;5(1):19–25.
15. Al-Zoubi H, Alharbi AA, Ferguson DJ, Zafar MS. Frequency of impacted teeth and categorization of impacted canines: A retrospective radiographic study using orthopantomograms. *Eur J Dent*. 2017;11(1):117–21.
16. Beshlawy DE, Ahmed DF. Radiographic assessment of impacted maxillary canine position using CBCT: A comparative study of 2 methods. *Egypt Dent J*. 2019;65(4):3393–3402.
17. Mohammed AK, Sravani G, Vallappareddy D, Rao AR, Qureshi A, Prasad AN. Localization of impacted canines-a comparative study of computed tomography and orthopantomography. *J Med Life*. 2020;13(1):56–63.
18. Sarıkır Ç, Alkurt MT, Değerli S, Altunkaynak B, Peker I. Comparison of panoramic radiography and cone-beam computed tomography for qualitative and quantitative measurements regarding localization of permanent impacted maxillary canines. *Acta Odontol Turc*. 2017;34:1–11.
19. Counihan K, Al-Awadhi EA, Butler J. Guidelines for the Assessment of the Impacted Maxillary Canine. *Dent Update*. 2013;40:770–7.

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